National Aeronautics and Space Administration

SC-NGR-22-009-125

Semi-annual Progress Report

March 1967

N67-86603 (ACCESSION NUMBER)
3 (PAGES)
CR#88994 (NASA CR OR TMX OR AD NUMBER)
(THRU)
(CODE)
(CATEGORY)
FACILITY FORM 602

Professor Harry C. Gatos
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

Semi-annual Progress Report

SC-NGR-22-009-125

March 1967

The superconducting transition temperature (T_c), the upper critical field (H_{c2}) and the current carrying capacity (J_c) were determined across the Nb-Hf alloy system. A maximum in T_c of 9.8°K was found to occur in the alloy composition (90 - 10 in atom percent) with a mean number of valence electrons per atom (NVE) of 4.9 and a maximum in H_{c2} of 66 kgauss in the alloy composition (50 - 50 in atom percent) with a NVE of 4.5. The fact that the two maxima occur at different values of NVE is of particular interest especially since in the Nb-Ti system both maxima occur at a NVE of 4.5. It is likely that the large size of the Hf atom is responsible for the unexpectedly high H_{c2} value and the occurence of the two maxima at different NVE.

Among the transition metal ternary systems the titanium-niobium-vanadium has been selected. Since the properties of the binary alloys of this system have been previously investigated it was felt that the superconducting behavior of the ternary system would be of fundamental importance with regard to the effects of atomic size and valence electron concentration. The complete miscibility of this system above 1000° is another distinct advantage. A large number of different compositions (forty) within this ternary system have been prepared by arc melting. From the resulting "buttons" strips have been prepared which are suitable for measuring the superconducting transition temperatures as well as the current carrying capacity and the critical magnetic fields. The transition temperature measurements have been completed in all of the above alloys; the results are now being carefully analyzed for general trends across the phase diagram. Although titanium itself exhibits a transition temperature at 0.46°K its presence in the ternary alloys is quite marked in terms of its effects on the superconducting characteristics. The results on the T_c values will be presented in the next semi-annual report.

The J_c of NbN exhibits a sharp peak as a function of magnetic field just before it drops to zero. To elucidate the nature of this peak several samples of NbN prepared under various conditions are being irradiated with fast neutrons (5×10^{19} flux). Their superconducting properties as affected by radiation damage will be studied in the hope of understanding the behavior of their compounds. Additional materials are being irradiated (in a specially built water cooled container) with fast neutrons: the σ-phases of the Mo-Re and Nb-Al systems and Nb-Ti-V alloys. The results of the latter alloys should be of particular interest in view of the extensive results being obtained under various heat treatments.

Attempts were made to prepare V-Ti-U^{235} alloys which would then be submitted to internal fission by appropriate neutron irradiation. However, it was not possible by arc melting techniques to achieve homogeneous alloys apparently due to the large size of the U^{235} atom.

A new technique has been recently developed in the physics department of M.I.T. for measuring the specific heat of materials by using a continuous warming method. Specific heat measurements provide a direct way of arriving at the density of states at the Fermi surface and thus the ultimate understanding of the superconducting behavior of materials. The transition metal carbides were chosen for specific heat measurements particularly because their superconducting properties are very sensitive to structure and composition changes. The following carbides have been prepared by hot pressing techniques for specific heat measurements: TiC, ZrC, HfC, VC, NbC, TaC, MoC and WC. It is apparent that these carbides represent a broad spectrum of transition metals with a significant variation in the mean number of valence electrons per atom.